PATENT SPECIFICATION

(11) 1 206 143

DRAWINGS ATTACHED

1 206 143

(21) Application No. 40804/67 (22) Filed 6 Sept. 1967
(31) Convention Application No. 210 (32) Filed 6 Sept. 1966 in
(33) Hungary (HU)
(45) Complete Specification published 23 Sept. 1970
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(52) Index at acceptance
H1S 2F 5 6A4 6AX 6B7X 6C2 6C5 6C6A 6CX

(54) ELECTRIC RESISTORS

SPECIFICATION NO 1206143

By a direction given under Section 17(1) of the Patents Act 1949 this application proceeded in the name of VIDEOTON RADIO ES TELEVIZIOGYAR, a Hungarian Body Corporate, of Berenyi Ut, Szekesfehervar, Hungary.

THE PATENT OFFICE

R 14256/1

The invention relates to electric resistors and to a process for their production.

The increasing use of transistors has resulted in attempts to reduce the dimensions of electronic circuits and constructions, whilst increasing the useful life and the reliability of apparatus employing the transistors.

Layer-type and solid-type resistors in which the conducting layer is formed in the longitudinal direction of the resistor are difficult to miniaturise. It is difficult to construct sub-miniature resistors of a few ohms and in the case of resistors of several megohms, problems arise owing to the non-uniformity of the surface of the thin resistance layer applied to a ceramic substrate and owing to burning which occurs at the resistor due to the considerable current density and the reliability of resistors is sometimes impaired by these factors. Resistors produced by the application of a resistance layer to a ceramic substrate, and solid resistors (i.e. those of low ohmic value) have the disadvantage that they are costly to produce owing to the unfavourably large amount of space required in their production.

In order to improve the quality and reliability of the known resistors, the principle of transverse conduction has recently been applied and the current conductors are made parallel and surround the resistance wafer produced by a preceding pressing. However, such resistors have the disadvantage that disruptions occur at various points owing to the non-uniformity of the wafer surface.

This invention aims to obviate the aforesaid disadvantages by means of a process

the end portions of metallic contact lead-out members into a liquid resistance material comprising an organic binder and either an organic or inorganic conductor material, withdrawing the end portions of the lead-out members from the material so that a deposit of the material is formed on the end portions of the members, and drying the deposit at elevated temperature.

This invention also provides an electric resistor having, when in operation, transverse and/or longitudinal current conduction with respect to the dimensions of the resistor, the resistor comprising metallic contact lead-out members having at one end of each thereof resistance material which has been deposited on the ends in a liquid state and which has been hardened by being subjected to an elevated temperature, the resistance material comprising an organic binder and either an organic or inorganic conductor material. Of the many organic and inorganic conductor materials which may be employed, lamp black is a preferred organic conductor material and powdered silver is a preferred inorganic conductor material.

In the process of the invention, the desired ohmic value may be produced by adjusting the concentration and viscosity of the liquid resistance material, and/or the area of the lead-out members and the distance between the lead-out members, and/or the number of dips, and/or the duration and temperature at which the drying of the drop of resistance material is carried out. Repeated dipping causes the cross-section of the resistor to increase, and this causes the ohmic value to decrease. Enlarging the area of

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(54) ELECTRIC RESISTORS

(71) We, HIRADASTECHNIKAI IPARI KUTATO INTEZET, a body corporate duly organised under the laws of Hungary, of 67 Vorosmarty utca, Budapest VI, Hungary, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to electric resistors and to a process for their production.

The increasing use of transistors has resulted in attempts to reduce the dimensions of electronic circuits and constructions, whilst increasing the useful life and the reliability of apparatus employing the transistors.

Layer-type and solid-type resistors in which the conducting layer is formed in the longitudinal direction of the resistor are difficult to miniaturise. It is difficult to construct sub-miniature resistors of a few ohms and in the case of resistors of several megohms, problems arise owing to the non-uniformity of the surface of the thin resistance layer applied to a ceramic substrate and owing to burning which occurs at the resistor due to the considerable current density and the reliability of resistors is sometimes impaired by these factors. Resistors produced by the application of a resistance layer to a ceramic substrate, and solid resistors (i.e. those of low ohmic value) have the disadvantage that they are costly to produce owing to the unfavourably large amount of space required in their production.

In order to improve the quality and reliability of the known resistors, the principle of transverse conduction has recently been applied and the current conductors are made parallel and surround the resistance wafer produced by a preceding pressing. However, such resistors have the disadvantage that disruptions occur at various points owing to the non-uniformity of the wafer surface.

This invention aims to obviate the aforesaid disadvantages by means of a process which renders possible under extremely economical conditions the mass production of sub-miniature resistors of excellent reliability.

Accordingly, this invention provides a process for the production of an electric resistor having, when in operation, transverse and/or longitudinal current conduction with respect to the dimensions of the resistor, which process comprises dipping the end portions of metallic contact lead-out members into a liquid resistance material comprising an organic binder and either an organic or inorganic conductor material, withdrawing the end portions of the lead-out members from the material so that a deposit of the material is formed on the end portions of the members, and drying the deposit at elevated temperature.

This invention also provides an electric resistor having, when in operation, transverse and/or longitudinal current conduction with respect to the dimensions of the resistor, the resistor comprising metallic contact lead-out members having at one end of each thereof resistance material which has been deposited on the ends in a liquid state and which has been hardened by being subjected to an elevated temperature, the resistance material comprising an organic binder and either an organic or inorganic conductor material. Of the many organic and inorganic conductor materials which may be employed, lamp black is a preferred organic conductor material and powdered silver is a preferred inorganic conductor material.

In the process of the invention, the desired ohmic value may be produced by adjusting the concentration and viscosity of the liquid resistance material, and/or the area of the lead-out members and the distance between the lead-out members, and/or the number of dips, and/or the duration and temperature at which the drying of the drop of resistance material is carried out. Repeated dipping causes the cross-section of the resistor to increase, and this causes the ohmic value to decrease. Enlarging the area of

the lead-out members has the same effect as repeated dipping. An increase in the duration of drying causes the ohmic value to decrease.

The process of the invention enables many electrical and mechanical faults arising in layer-type and solid-type resistors to be obviated. In addition, contact resistance from the mechanical attachment of the lead-out wire, for example, of the solder or of the securing cap, is avoided as is unsafe lead-out wire contact and mechanical strength fluctuations. The resistors produced by the process of the invention may have a substantially higher specific loading capacity than known resistors, since the heat evolved during operation can be led out even from the centre of the resistor by the lead-out members, which have high thermal conductivity, thus avoiding burn-out at the centre of the resistor. Furthermore, the process of the invention enables the readily automated mass production of subminiature resistors of widely varying orders of magnitude.

An embodiment of the process according to the invention will be more fully described by way of example with reference to the accompanying drawing, in which:

Figure 1 shows a longitudinally directed carbon or metal layer resistor known *per se* having a longitudinal resistance strip,

Figure 2 shows, on an enlarged scale, the detached resistance strip of the resistor shown in Figure 1,

Figure 3 shows in section a transverse resistance element and illustrates the application of the principle of transverse conduction,

Figure 4 shows diagrammatically an axial section, on an enlarged scale, of a subminiature first resistor having transverse and longitudinal conduction which has been produced in accordance with the invention,

Figure 5 is a transverse section of the subminiature first resistor,

Figure 6 shows diagrammatically an axial section of a second resistor having substantially only transverse conduction and produced by the process of the invention, with stepped construction of the resistance layer, and

Figure 7 is a transverse section of the second resistor.

Referring to the drawing, the resistor shown in Figures 1 and 2 has a resistance layer which is 100 mm long, 1 mm wide, and less than 1 μ thick. It is in the form of a strip of non-uniform cross-section. The arrow shown in Figure 2 indicates the direction of the current, in accordance with the conduction taking place in the longitudinal direction. In other words, there is longitudinal current conduction because the value of the resistance can be measured in practice between the ends of the strip since the cross-section of the strip is very small relative to the length of the strip.

In solid resistors produced in rod or cylindrical form by pressing from semi-conductor material embedded in a binding agent, burning-out of the central part of the resistor often takes place owing to defective heat conduction. In the course of the reliability tests, a defectiveness of 0.009% in 1000 hours is generally found in the base of crystal carbon layer resistors, and a defectiveness of 0.0005% in 1000 hours in the case of solid resistors.

Referring to Figure 3, a pre-stressed plate-form resistance body 3 is gripped between lead-out members 1 and 2. The direction of the current is indicated by the arrow and it will be seen that this is in a transverse direction with respect to the length of the resistor body. Such a resistor may be 6.5 mm long, 2.8 mm wide and 1.7 mm thick. The dimensions cannot be reduced much more because of technological difficulties.

Referring to Figures 4 and 5, one end of each of two current lead-out members 1 and 2 is surrounded by resistance material 3 by dipping the said ends in liquid resistance material. The resistance material 3 is protected by an enveloping protective layer 4. The body of the resistor has substantial proportions in both the longitudinal and transverse directions and, accordingly, the resistor has both longitudinal and transverse conduction properties. In this resistor, current flows only between the lead-out members 1 and 2.

Referring to Figures 6 and 7, a current lead-out member 1 is surrounded by a cylindrical lead-out member 2. Disposed between the lead-out members 1 and 2 are two separate layers of resistance material produced by first dipping the lead-out member 1 into liquid resistance material to form the inner layer 3A, surrounding the lead-out member 1 and the layer 3A with the cylindrical lead-out member 2, and dipping the whole assembly of members 1 and 2 and the layer 3A into more liquid resistance material so that a second layer 3B is formed between the layer 3A and the member 2. The open end of the resistor is closed by closure material 5 and the outside of the cylindrical lead-out member 2 is wiped free of resistance material whilst the resistance material is still liquid. Because of the location of the members 1 and 2, the resistance material participates in conducting and the current can flow between the lead-out members 1 and 2 in a radial direction.

In accordance with the invention, for example, a 100 ohm resistor was produced as follows. Firstly, the material to form the drop on the contact lead-out members was

formed by mixing or grinding in a ball mill 300 g. of carbon black, 98 g. of epoxy fatty acid ester, 42 g. of melamine and 90 ml. of toluene. Into the mass thus produced, were dipped two contact lead-out wires having a diameter of 0.5 mm and spaced 1 mm apart. The contact wires were subsequently withdrawn and the ends thereof remained connected together by a drop of the resistance material adhering to the two contact lead-out wires. After drying for 10 minutes, the drop was further dried by being baked at 180°C for one hour. The resistor thus obtained was protected by a coating of any appropriate protective material, for example, a lacquer. If desired, powdered silver could have been used instead of the carbon black.

WHAT WE CLAIM IS:—

1. A process for the production of an electric resistor having, when in operation, transverse and/or longitudinal current conduction with respect to the dimensions of the resistor, which process comprises dipping the end portions of metallic contact lead-out members into a liquid resistance material comprising an organic binder and either an organic or inorganic conductor material, withdrawing the end portions of the lead-out members from the material so that a deposit of the material is formed on the end portions of the members, and drying the deposit at an elevated temperature.

2. A process according to Claim 1 in which the binder contains an epoxy fatty acid ester, melamine and toluene.

3. A process according to Claim 1 or Claim 2 in which the conductor material is either lamp black or powdered silver.

4. A process according to any one of the preceding claims in which a desired ohmic value is obtained by adjusting the concentration and viscosity of the resistance material, and/or the area of the lead-out members and the distance between the lead-out members, and/or the number of dips, and/or the duration and temperature at which the baking of the drop of material is carried out.

5. A process according to Claim 1 and substantially as herein described for the production of an elastic resistor.

6. An electric resistor whenever produced by a process as claimed in any one of the preceding claims.

7. An electric resistor having, when in operation, transverse and/or longitudinal current conduction with respect to the dimension of the resistor, the resistor comprising metallic contact lead-out members having at one end of each thereof resistance material which has been deposited on the ends in a liquid state and which has been hardened by being subjected to an elevated temperature, the resistance material comprising an organic binder and either an organic or inorganic conductor material.

8. An electric resistor according to Claim 7 in which the binder contains an epoxy fatty acid ester, melamine and toluene.

9. An electric resistor according to Claim 7 or Claim 8 in which the conductor material is either lamp black or powdered silver.

10. An electric resistor according to Claim 7 substantially as herein described with reference to Figures 4 and 5 or to Figures 6 and 7 of the accompanying drawings.

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1206143 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1

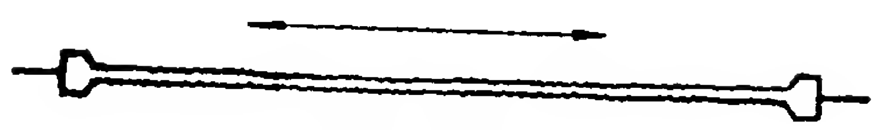

Fig.2

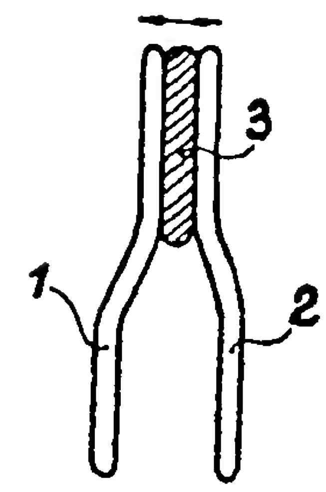

Fig.3

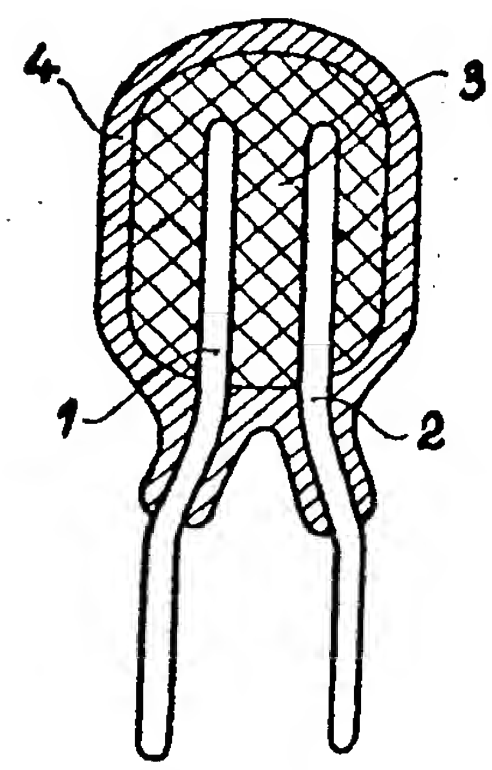

Fig.4

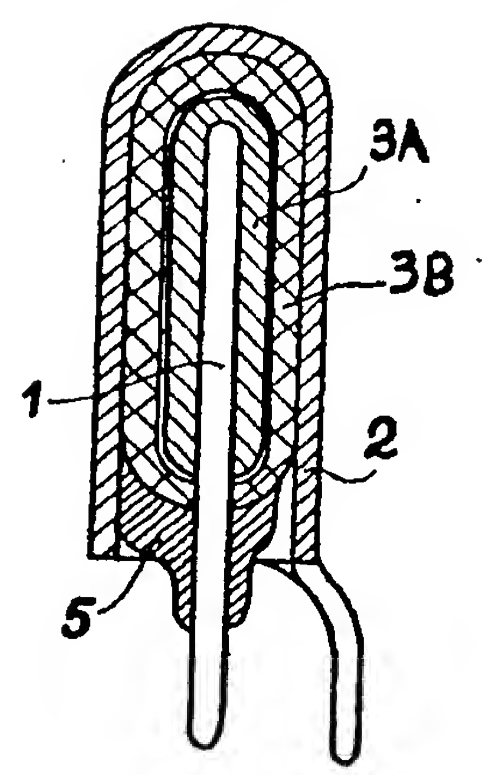

Fig.6

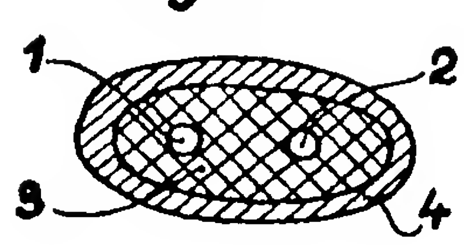

Fig.5

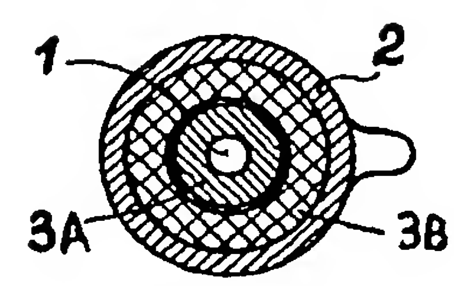

Fig.7

DOCKET NO: GR 00 P 1993 7

SERIAL NO: 10/007,390

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